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THE GLACIATED AREA OF NORTH AMERICA.

BY REV. G. FREDERICK WRIGHT.

I AM asked to give, for the convenience of the readers of the NATURALIST, a brief summary of the present results of my glacial investigations during the past ten years. This I am enabled to do more concisely because of the plates which I am permitted by my publisher to use so freely.¹

The special marks characteristic of the glaciated region consist of striated rocks, striated pebbles, transported boulders and an unstratified deposit called "till." These are now too familiar to need description. My investigations have chiefly had in view the determination and study of the southern boundary of the glaciated area in Eastern United States. I have zigzagged the whole boundary from the Atlantic ocean to the State of Illinois, the results being given in the accompanying plates, the correctness of which the reader may readily verify for himself, for when one has become once familiar with the glacial signs indicated above, he cannot fail to notice their conspicuous absence south of the boundary line indicated.

It will be observed that in New England the rivers reach the sea inside the glacial limit, and they are all characterized throughout their whole extent by terraces of coarse gravel, varying

¹ For fuller details of my work see Proceedings of the Boston Society of Natural History, Vol. XIX, pp. 47-63, Vol. XX, pp. 210-220, Vol. XXI, pp. 137-145; Geological Report of New Hampshire, Vol. III, pp. 167-170; *American Journal of Science*, Vol. CXXI, pp. 120-123, Vol. CXXVI, pp. 44-56; AMERICAN NATURALIST, Vol. XVIII, pp. 563-567; but especially my "Studies in Science and Religion": Andover: W. F. Draper. 1882, pp. 256-350, and the "Glacial Boundary in Ohio, Indiana and Kentucky": Cleveland: Western Reserve Historical Society. 1884, pp. 86; Ohio Geological Report, Vol. V, pp. 750-771.

in height from a few feet to one hundred or more feet above the present flood-plain. These are now shown to have been deposited during the last stages of the glacial period by the "immense spring freshets" which marked the melting away of the vast body of ice. Many of these gravel deposits, however, are un-

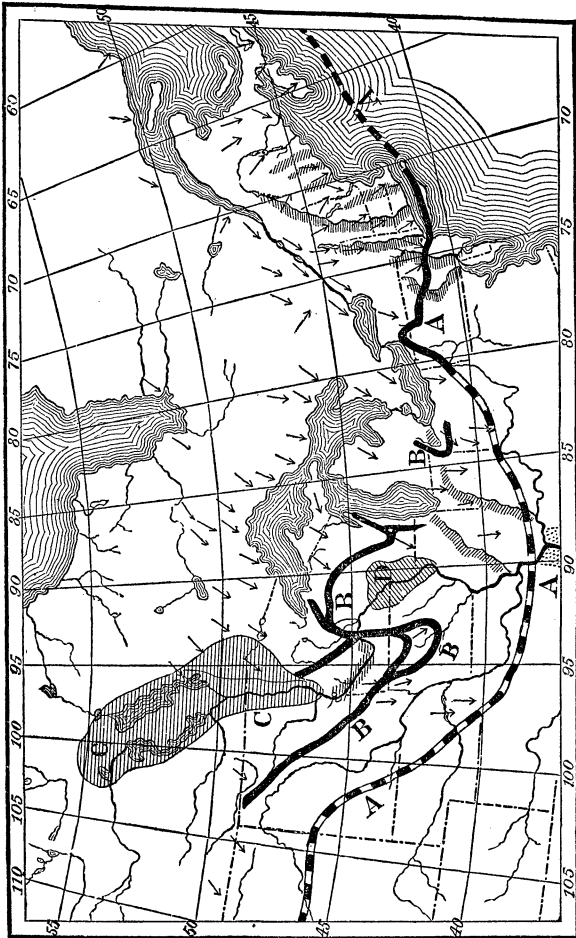


FIG. 1 (taken from the author's "Studies in Science and Religion") shows a portion of the glaciated area of North America. AA represents the boundary of the glaciated area. The continuous line is from actual survey in 1881. (For completion to Illinois see Figures 4 and 10. The broken part is still somewhat conjectural.) BB marks special glacial accumulations. CC represents Lake Agassiz, a temporary body of water formed by the damming up by ice of the streams flowing into Hudson's bay, the outlet being, meanwhile, through the Minnesota. D is a driftless region which ice surrounded without covering. The arrows indicate the direction of glacial scratches. The names of New England and the terraces upon the Western rivers are imperfectly shown upon so small a map.

connected with present water-courses, but run across the country for scores of miles in long, tortuous systems of gravel ridges from a few feet to one hundred feet above the valleys in which they are situated. These are now called "kames," and correspond to "åsars" in Sweden, and were evidently formed contemporaneously with the terraces,

West of New Jersey streams are continually encountered whose sources are in the glaciated area, and whose mouths are in the unglaciated. Fig. 2 illustrates this in the case of the Delaware, which is of special interest because the glacial terraces

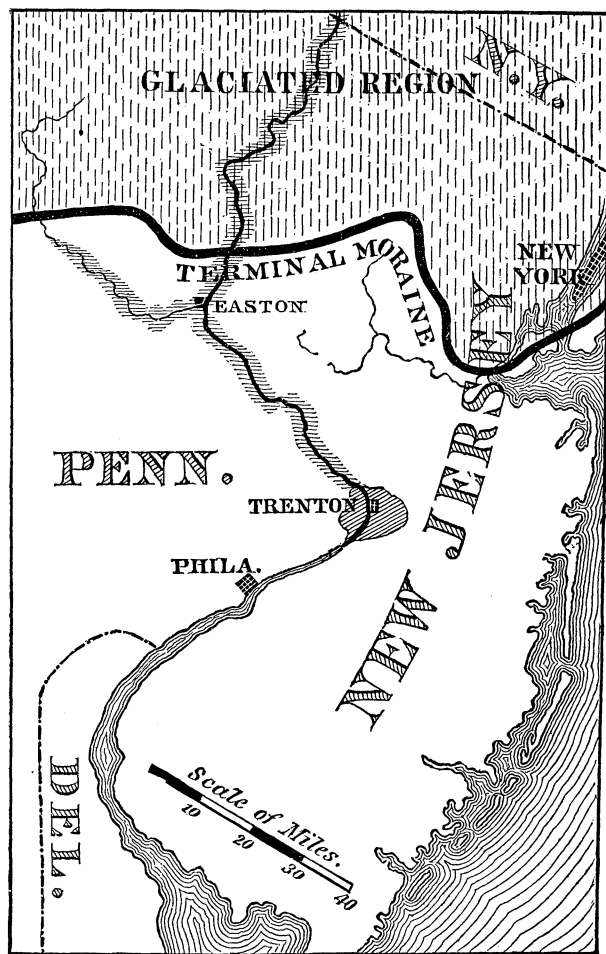


FIG. 2.—This cut (taken from "Studies in Science and Religion") shows, in addition to the glaciated area of New Jersey, the glacial terraces of gravel along the Lehigh and Delaware rivers, and also the "Delta terrace" at Trenton, fifty feet above the river, in which Dr. C. C. Abbott has found palæolithic implements.

can be traced continuously down the river from the boundary line to a "delta terrace" of large extent at Trenton, whose surface is fifty feet above the present flood-plain. It is in this glacial terrace that Dr. C. C. Abbott has found so many palæolithic im-

plements.¹ Professor Cook has also found in these same glacial gravels the tusk of a mastodon. In riding from New York to Philadelphia on the New Jersey Central railroad, the train passes

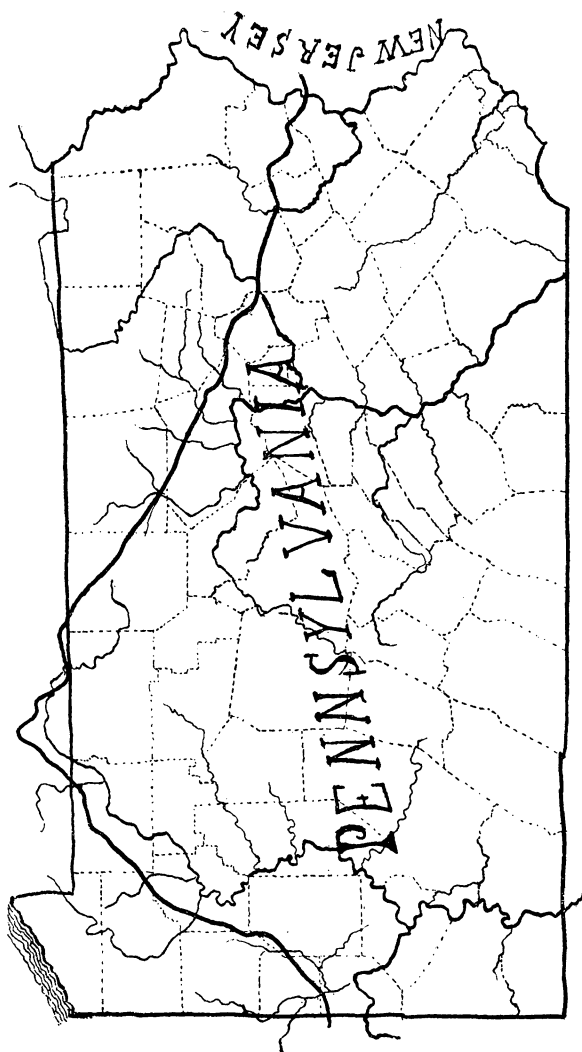


FIG. 3.—The broad, black line shows southern boundary of glaciated area of Pennsylvania. This and the remaining figures are from the "Glacial Boundary in Ohio, Indiana and Kentucky," published by the Cleveland Historical Society.

from the glaciated to the unglaciated region at Metuchen, and on the Bound Brook route at Plainfield, and in both cases the boundary line is marked by extensive accumulations of gla-

¹ See his "Primitive Industry," Salem, Mass., 1881.

ciated material rising in hills from thirty to seventy feet in height.¹

Fig. 3 shows the boundary line across Pennsylvania with a remarkable bend to the north as it crosses the Appalachian mountains, passing through Northampton, Monroe, Luzerne, Columbia, Lycoming, Tioga and Potter counties, thence through Allegheny and Cattaraugus counties in New York, thence back again in Pennsylvania through Warren, Venango, Mercer and Lawrence counties.²

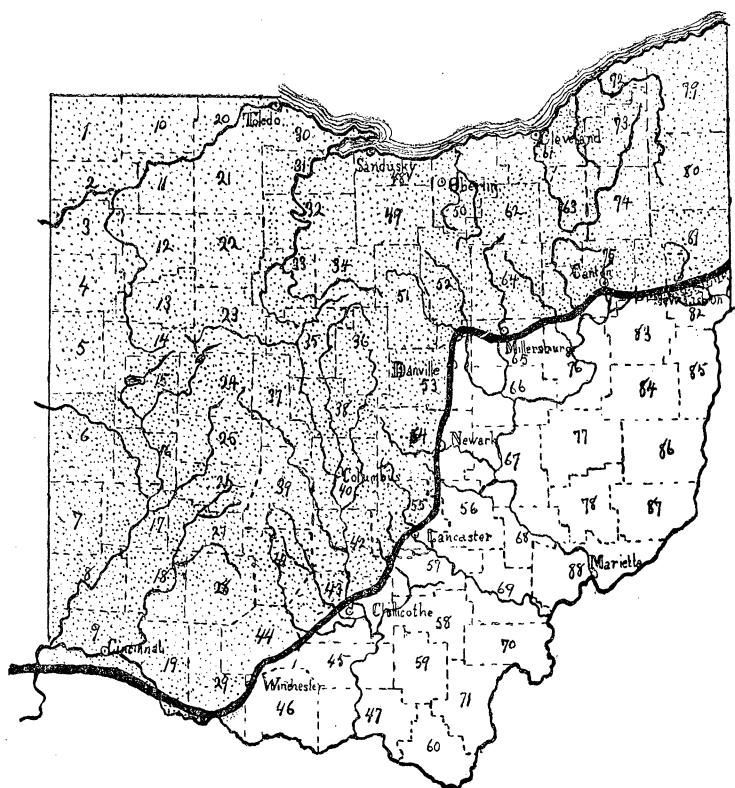


FIG. 4.—Map showing southern boundary of glaciated area of Ohio.

In Fig. 4 the dotted portion shows the glaciated area of Ohio.

¹ For details respecting the boundary in New Jersey, see the report of Professors Cook and Smock for 1878, 1879, 1880.

² For details see the joint report of Professor H. Carvill Lewis and myself, soon to be issued by Professor Lesley as a part of the State geological report.

The accompanying list of counties is numbered to correspond to those in the plate :

| | | | |
|-----------------|----------------|----------------|-----------------|
| 1. Williams. | 23. Hardin. | 45. Pike. | 67. Muskingum. |
| 2. Defiance. | 24. Logan. | 46. Adams. | 68. Morgan. |
| 3. Paulding. | 25. Champaign. | 47. Sciota. | 69. Athens. |
| 4. Van Wert. | 26. Clarke. | 48. Erie. | 70. Meigs. |
| 5. Mercer. | 27. Greene. | 49. Huron. | 71. Gallia. |
| 6. Darke. | 28. Clinton. | 50. Lorain. | 72. Lake. |
| 7. Preble. | 29. Brown. | 51. Richland. | 73. Geauga. |
| 8. Butler. | 30. Ottawa. | 52. Ashland. | 74. Portage. |
| 9. Hamilton. | 31. Sandusky. | 53. Knox. | 75. Stark. |
| 10. Fulton. | 32. Seneca. | 54. Licking. | 76. Tuscarawas. |
| 11. Henry. | 33. Wyandot. | 55. Fairfield. | 77. Guernsey. |
| 12. Putnam. | 34. Crawford. | 56. Perry. | 78. Noble. |
| 13. Allen. | 35. Marion. | 57. Hocking. | 79. Ashtabula. |
| 14. Auglaize. | 36. Morrow. | 58. Vinton. | 80. Trumbull. |
| 15. Shelby. | 37. Union. | 59. Jackson. | 81. Mahoning. |
| 16. Miami. | 38. Delaware. | 60. Lawrence. | 82. Columbiana. |
| 17. Montgomery. | 39. Madison. | 61. Cuyahoga. | 83. Carroll. |
| 18. Warren. | 40. Franklin. | 62. Medina. | 84. Harrison. |
| 19. Clermont. | 41. Fayette. | 63. Summit. | 85. Jefferson. |
| 20. Lucas. | 42. Pickaway. | 64. Wayne. | 86. Belmont. |
| 21. Wood. | 43. Ross. | 65. Holmes. | 87. Monroe. |
| 22. Hancock. | 44. Highland. | 66. Coshocton. | 88. Washington. |

The five figures numbered 5, 6, 7, 8, 9, give the section that I have zigzagged through Ohio on the scale of six miles to the inch. Upon the first two plates I endeavored to represent the boundary of what Professor Lewis and myself called the "fringe"; the broad dark line representing the limit of the more considerable glacial deposits, the broken line the extreme limit of glacial boulders out of reach of the water courses. West of Stark county I did not think it best to draw this distinction, and my line marks the extreme limit of true glacial action. It will be interesting and important for other investigators to examine the fringe throughout the whole line, and inquire why in some places it is so broad and in other places there is none at all. Glacial deposits of special amount are found at the following places at or near the margin in Ohio: Columbiana county—Palestine, the northern part of Centre township, and New Alexandria; Stark county—two miles south-west of Canton, north of Wilmot; Holmes county—a little north of the line throughout; Knox county—Danville, Millwood, Bladensburg; Licking county—Wilkin's run, Newark, Amsterdam; Perry county—Thornville; Fairfield county—Rushville, the vicinity of Bern station, Lan-

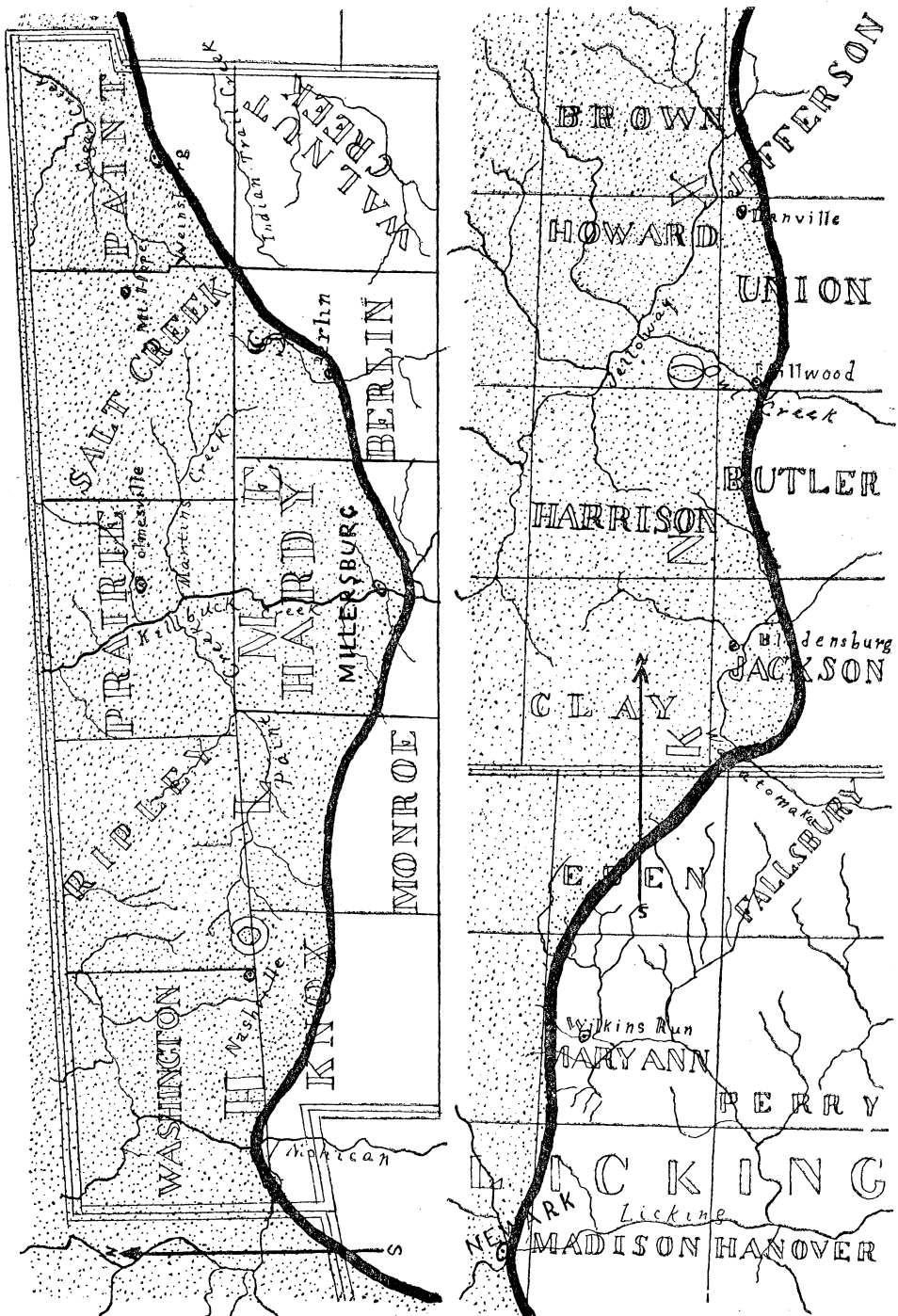


FIG. 6.—Glacial Limits in Ohio.

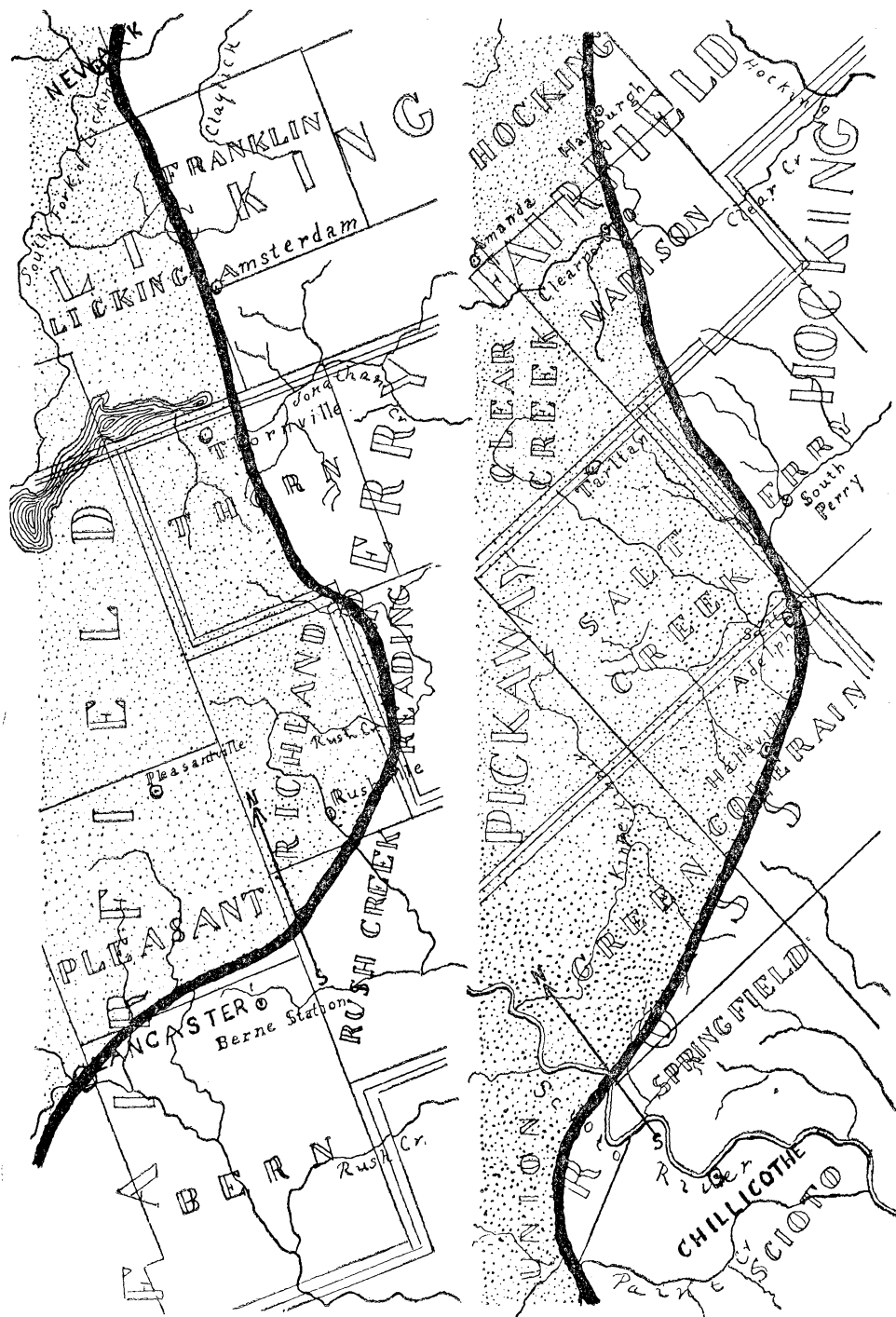


FIG. 7.—Glacial Limits in Ohio.

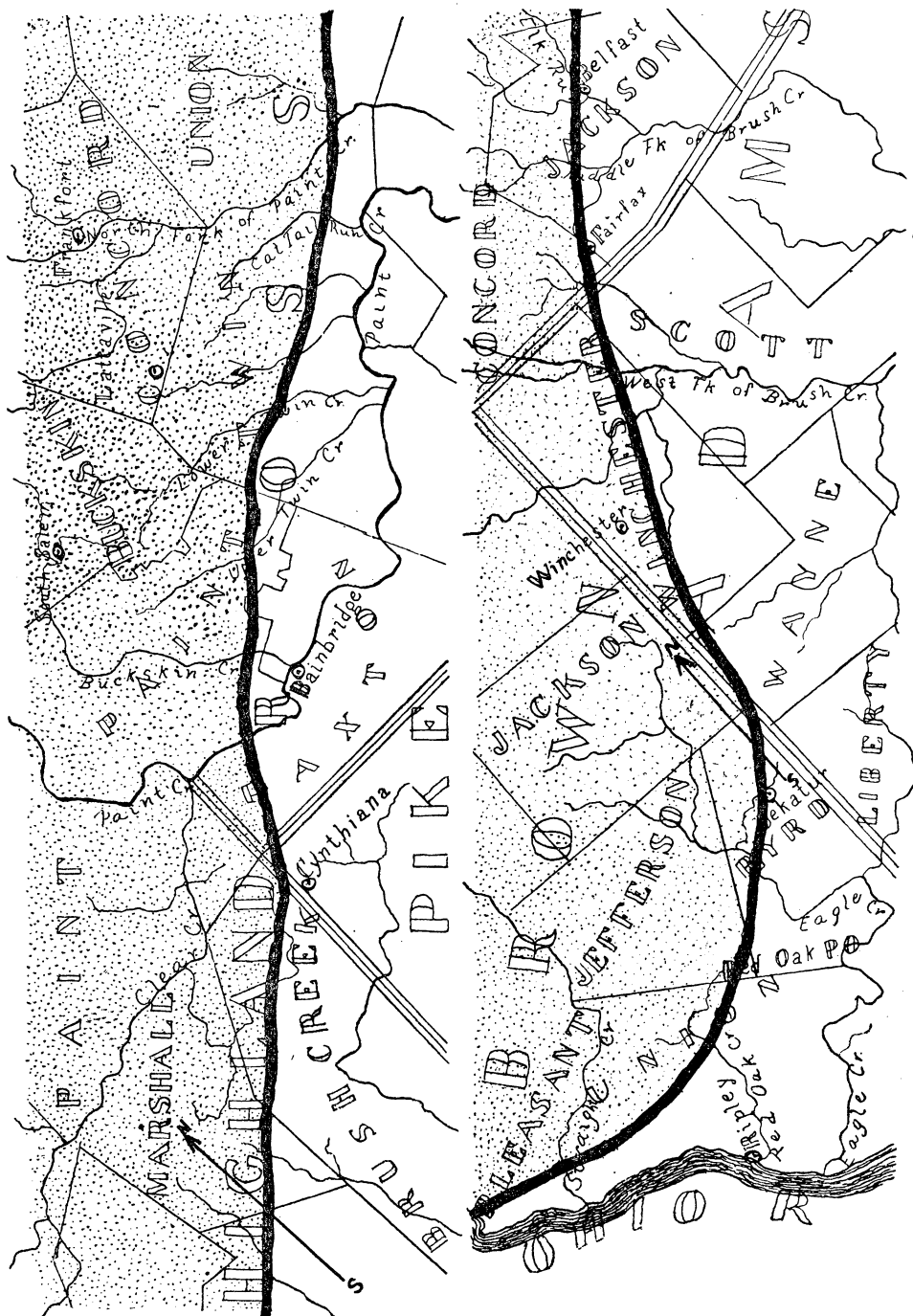


FIG. 8.—Glacial Limits in Ohio.

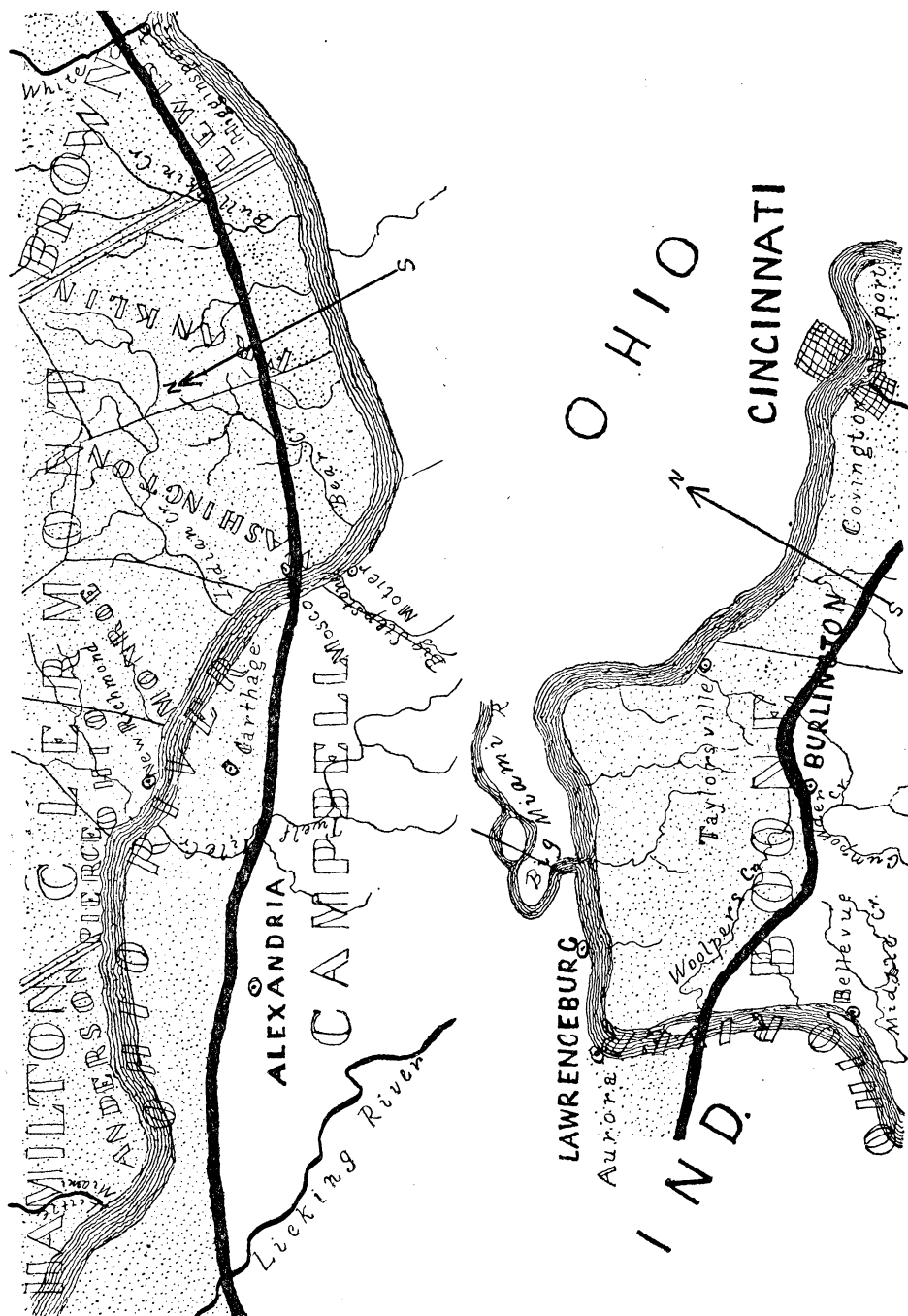


FIG. 9.—Glacial Limits in Ohio.

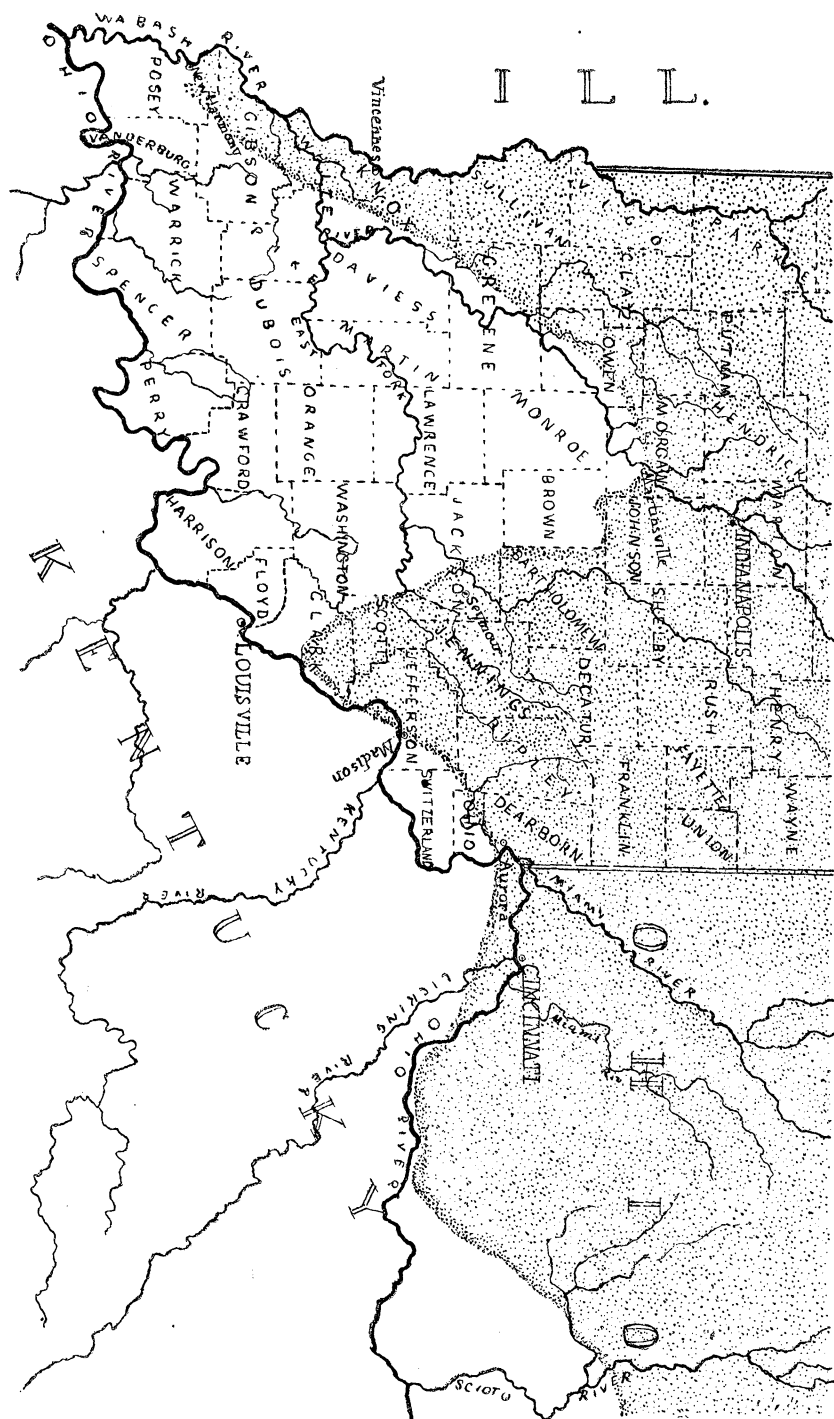


FIG. 10.—Map of Southern Indiana, showing glacial boundary.

caster and Clearport; Pickaway county—Tarlton; Ross county—Adelphi, Hallsville and throughout Green, Union, Concord and Buckskin townships; Highland county—in Paint and Northern Marshall townships; Adams county—the vicinity of Winchester; Kentucky—in the vicinity of Carthage, Burlington and Woolpers creek.

Figure 10 shows more distinctly the relation of the glacial limit to the Ohio river at Cincinnati, producing the supposed ice dam discussed in a previous number of the *NATURALIST* (see Vol. XVIII, June, 1884, pp. 563-567), and the line across Indiana traced by me last summer. The northern part of Dearborn, the whole of Ripley, Decatur, Jennings and Bartholomew counties are deeply covered with true glacial drift, and the extreme limit is pretty easily ascertained, though the deposits in Jefferson, Clark and Scott counties are scanty as compared with the counties farther north. The highest point of the State is in Brown county, 1150 feet above the sea. The ice deposits do not reach to that point, but are very deep and extensive a few miles north over the southern part of Johnson county. In Owen county there are numerous striæ running 50° east of south, or nearly at right angles to the glacial limit. The glacial deposits in Southwestern Indiana are covered with "loess," which is doubtless a water deposit, and will, to the westward, probably greatly increase the difficulty of tracing the exact southern boundary of the glaciated area.

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ON THE EVIDENCE THAT THE EARTH'S INTERIOR IS SOLID.

BY DR. M. E. WADSWORTH.

(*Continued from page 686, July number.*)

Conclusions.—Starting with the common belief that the earth was once an intensely hot gaseous body, it follows that when cooled from a gaseous to a liquid state, convection would cause the intermingling of all the liquid portions only so long as the heat kept every part at the same density. As soon as an especial difference in density manifested itself (if it had not already done so in the gaseous state) the heavier materials would sink towards the interior and the lighter pass outward towards the exterior. So soon as these materials became viscous the inter-